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Day-of-the-Week Effect and January Effect Examined in Copper and Aluminum Metals

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Abstract: This study examined the day-of-the-week effect and January Effect in the precious metals copper and aluminum for the period August 27th 1987 through October 12th 2012. The results of this study indicate the presence of the day-of-the-week effect in both copper and aluminum markets. The results of this study also indicate that there may be a daily seasonality in the variance of these metals. However, the findings of this study shows that January effect in the copper and aluminum markets does not exists in the mean returns or variance of these metals.

Key words: day-of-the-week effect; January effect; precious metals
JEL codes: G100, O16

1. Literature Review

1.1 Day-of-the-Week Effect in Equity and Currency Markets

Day-of-the-week effect is a well documented seasonal anomaly in the US equity, international equity and in foreign exchange markets. According to the *day-of-the-week effect*, the daily returns in financial markets on different days of week are statistically not the same. Specifically, Mondays' returns are observed to be significantly negative, while Fridays' returns are found to be statistically positive. For example, Aggarwal and Rivoli (1989), Dyl and Maberly (1992), Kohli (1996), and Pettengill, Wingender and Kohli (2004) have found the existence of the *day-of-the-week effect* in the U.S. and in overseas equity markets. McFarland, Pettit, and Sung (1982) have investigated the *day-of-the-week effect* in one of the earliest studies in foreign exchange markets. MPS observed that the distribution of price changes on Mondays was different from the distribution of price changes on other days of the week. Interestingly, MPS findings indicate negative price changes on Fridays and positive price changes on Mondays which are opposite to general findings of the *weekend effect* in the equity markets. Similarly, Jaffe and Westerfield (1985, 1985) report a higher than average return on Wednesday and a lower than average return on Friday for all currencies. Yamori and Kurilhara (2004) report the presence of the *day-of-the-week effect* in some currencies in 1980s and absence of the effect in most currencies. Aydogan and Booth (2005) report presence of the *day-of-the-week effect* in Turkish and German Markets. Kohli (2004, 1995) explored seasonal anomalies in selected and dominant currencies.

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1.2 January Effect in Equity and Currency Markets

In the economic and finance literature, *January Effect* is also reported in US equity, international equity and currency markets. McFarland, Pettit, and Sung (1982), Jaffe and Westerfield (1985, 1985) in some of the earliest studies of January Effect, report the presence of this seasonal anomaly in domestic and overseas equity markets. The *January effect* states that the mean monthly returns during month of January are greater than the mean monthly returns during any other month of a year. For example, Kohers and Kohli (1991) have provided supporting evidence for the presence of a robust *January effect* in major International stock markets including the United States. Kohli (1996) observed presence of January Effect in the foreign exchange markets. In another article, Kohli (1996) reported higher returns in month of January than the other months in international equity markets.

1.3 Day-of-the-Week Effect in Gold and Silver Markets

Precious metals (Gold, Silver and platinum) possess similar characteristics to money and medium of exchange and unit value (Goldman, 1956; Solt & Swanson, 1981; Dooley, Israd & Taylor, 1995). Ball, Torous and Tschoegl (1982) observed weekend effect in London fixing Gold prices from January 1975 through June 1979. Ma (1986) examined Gold markets and reports positive weekend returns prior to 1981 and negative Monday returns during the period 1981 through June 1985.

Lucey and Tully (2006) examined seasonality in the conditional and unconditional mean and variance of daily Gold and Silver contracts over the 1982-2002 periods. Using COMEX cash and futures data, they find weak evidence for the mean returns and strong evidence for the variance. They report negative Monday effect in both Gold and Silver, across cash and futures markets. Using a GARCH framework, they report that the Monday seasonal does not disappear, indicating that it is not a risk-related artefact, the Monday dummy in the variance equations being significant also.

Blose and Gondhalekar (2012) examined the Gold market for the period 1975 through 2011. They report that returns on the weekend are negative and significantly lower than the average returns during the week. They further examined the Gold weekend effect during bull and bear market phases. During bull markets, the difference between weekday and weekend returns is not significant. However, their findings show negative returns on the weekend which are significantly less than returns during the week during the bear market.

1.4 January Effect in Gold markets

Baur (2013) investigated monthly seasonal in Gold returns for each month from 1980 to 2010 and report that September and November are the only months with positive and statistically significant Gold price changes. This "autumn effect" holds unconditionally and conditional on several risk factors. Baur did not find monthly return pattern in the Silver prices. Coutts and Sheikh (2002) found no evidence of weekend effect or January effect on all Gold indexes on the Johannesburg Stock Exchange during the period 1987 through 1997.

The current study examines two calendar related seasonal anomalies (*Day-of-the-week effect and January effect*) in aluminum and copper over the period August 27th 1987 through October. This study examines both calendar related anomalies simultaneously and for recent and longer period.

2. Data and Methodology

The daily closing price data for Copper are collected from Bloomberg for the period December 7th 1988 through October 12th, 2012. Similarly, the monthly closing price data for Aluminum are collected from Bloomberg for the period August 27th through October 12th, 2012. The daily closing price is used to analyze day-of-the-week

effect while monthly closing price is used to examine the January Effect in the above commodities.

The following methodology is commonly used for examining seasonal anomalies in equity markets of US equity markets, international equity markets and foreign exchange markets. This paper uses the same methodology for analyzing calendar related anomalies in Copper and Aluminum markets.

2.1 Day-of-the-Week Effect

Equation (1) is used to compute daily returns for each commodity.

$$R_{it} = (P_{it} - P_{it-1})/P_{it-1} \quad (i = 1, 2) \tag{1}$$

Where P_{it} and P_{it-1} are the closing price in US Dollars for commodity i (per Pound for Copper and per metric ton for aluminum) on day_t and day_{t-1} respectively. The following Equation (2) is used to test for the presence of the day-of-the-week effect in the metals.

$$R_{it} = \beta_{iM}\ D_{iMt} + \beta_{iT}\ D_{iTt} + \beta_{iW}\ D_{iWt} + \beta_{iR}\ D_{iRt} + \beta_{iF}\ D_{iFt} + e_{it} \quad (i = 1\ 2) \tag{2}$$

Where, the D_j terms are used to represent the process describing the mean return on any day of the week. For example, β_{iM} indicates the mean return on Monday. Similarly, β_{iT}, β_{iW}, β_{iR}, and β_{iF} represent mean daily returns on Tuesday through Friday respectively. If the mean return on any day is not significantly different than zero then estimates of β_{iM} through β_{iF} will be zero, and the F-statistic measuring the joint significance of dummy variables should be insignificant.

2.2 January Effect

Monthly returns on both metals are calculated using the following Equation (3).

$$R_{jt} = (P_{jt} - P_{jt-1})/P_{jt-1} \quad (j = 1, 2) \tag{3}$$

Where P_{it} and P_{it-1} are the closing price in US Dollars for commodity i (per Pound for Silver and per metric ton for aluminum) during $month_t$ and $month_{t-1}$ respectively. Next, the following Equation (4) is used to test for the presence of the January effect in the commodities.

$$R_{jt} = \beta_{jJ}\ D_{jJt} + \beta_{jF}\ D_{jFt} + \beta_{jM}\ D_{jMt} + \ldots.\ \beta_{jD}\ D_{jDt} + e_{it} \quad (j = 1\ 2) \tag{4}$$

Where R_{jt} is the average return during calendar month (j) for commodity j. Thus, the random variable to be tested is the R_{ij}. Where, the D_j terms are used to represent the process describing the mean monthly return in month of the year. For example, β_{iJ} indicates the mean monthly return in January. Similarly, β_{jF}, β_{jM} through β_{jD} represent mean monthly returns during February, March through December respectively. If the mean monthly return during any month is significantly different than zero then estimates of β_{iJ} through β_{iD} will be zero, and the F-statistic measuring the joint significance of dummy variables should be insignificant.

3. Results

3.1 Day-of-the-week Effect

The results of the above analysis are reported in Tables 1-4. Basic statistics shown in Table 1 indicate that the Copper returns are negative on Monday and positive on all other week days. Standard deviations of returns for Monday to Friday are 0.016330, 0.017787, 0.018333, 0.017614, and 0.017138 respectively. Monday Copper returns have the lowest Kurtosis and highest skewness.

Table 2 shows the regression results for weekend effect in Copper returns. For example, Mondays' mean daily returns on Copper are -.000550 with p-value of 0.265, suggesting a probability of 26.5% that the mean daily Copper returns on Monday are statistically zero. Similarly, mean daily returns on Tuesday, Wednesday, Thursday and Friday are -0.000011 (p-value 0.98), 0.000614 (p-value 0.21), -0.000129 (p-value 0.793), and 0.001357

(p-value 0.006) respectively. Overall F-value of the regression is 2.073 with significance level of 0.066 indicating that mean daily returns for different days of the week on Copper are statistically different from each other.

Table 1 Moments of the Distribution by Day of the Week
August 27th 1987 through October 12th 2012

		Mean	Std. Dev.	Kurtosis	Skewness	N
Copper	Monday	-0.000550	0.016330	3.489	0.407	1244
	Tuesday	0.000011	0.017787	4.114	0.122	1244
	Wednesday	0.000613	0.018333	4.756	-0.314	1245
	Thursday	0.000129	0.017614	3.623	-0.555	1245
	Friday	0.001356	0.017138	4.960	-0.365	1245
Aluminum	Monday	-0.001630	0.015475	7.828	0.454	1311
	Tuesday	-0.000312	0.015978	7.052	-0.622	1311
	Wednesday	0.000369	0.015199	3.975	-0.029	1311
	Thursday	0.001314	0.016195	20.451	-1.356	1311
	Friday	0.000938	0.015425	6.396	-0.104	1312

Table 2 Daily Return Data from December 7th 1988 through October 12th 2012

Day-of-the-Week Effect Results for Mean Daily Returns on Copper

$R_{it} = \beta_{iM} D_{iMt} + \beta_{iT} D_{iTt} + \beta_{iW} D_{iWt} + \beta_{iR} D_{iRt} + \beta_{iF} D_{iFt} + e_{it}$

Day of the week	Unstandardized Coefficients		Standardized Coefficients	t	p-value*
	B	Std. Err.	Beta		
Monday	-0.000551	0.000495	-0.014100	-1.112754	0.265857
Tuesday	0.000011	0.000495	0.000285	0.022525	0.982030
Wednesday	0.000614	0.000495	0.015715	1.240261	0.214926
Thursday	0.000129	0.000495	0.003314	0.261504	0.793712
Friday	0.001357	0.000495	0.034752	2.742638	0.006112
F-Value	2.073	Sig. F**	0.066		N = 6,223

Note: * denotes probability that $\beta ij = 0$; ** denotes probability that $\beta_{iM} = \beta_{iT} = \beta_{iW} = \beta_{iR} = \beta_{iF}$

Table 3 Daily Return Data from August 27th 1987 through October 12th 2012

Day-of-the-Week Effect Results for Mean Daily Returns on Aluminum

$R_{it} = \beta_{iM} D_{iMt} + \beta_{iT} D_{iTt} + \beta_{iW} D_{iWt} + \beta_{iR} D_{iRt} + \beta_{iF} D_{iFt} + e_{it}$

Day of the week	Unstandardized Coefficients		Standardized Coefficients	t	p-value*
	B	Std. Err.	Beta		
Monday	-0.001631	0.000432	-0.046483	-3.770692	0.000164
Tuesday	-0.000312	0.000432	-0.008900	-0.721945	0.470354
Wednesday	0.000369	0.000432	0.010521	0.853487	0.393421
Thursday	0.001315	0.000432	0.037474	3.039916	0.002376
Friday	0.000939	0.000432	0.026774	2.171916	0.029898
F-Value	5.885	Sig. F**	0.0001		N = 6,556

Note: * denotes probability that $\beta ij = 0$; ** denotes probability that $\beta_{iM} = \beta_{iT} = \beta_{iW} = \beta_{iR} = \beta_{iF}$

Table 4 Levene's Test for Homogeneity of Variance for Day of the Weak Effect

	Levene Stat	Significance
Copper	3.799	0.051
Aluminum	20.846	0.000

The analysis reported in Table 2 indicates presence of the day-of-the-week effect in Copper returns. Specifically, the mean daily Copper returns on Monday are negative but statistically insignificant while the daily returns on Tuesday through Friday are positive. The mean returns on Friday are statistically greater than the other days of the week. These results are in line with gold markets reported by Ma (1986).

Basic statistics in Table 1 shows the negative Monday and Tuesday returns on Aluminum with negative skewness for Tuesday. Results for day-of-the-week effect on Aluminum are shown in Table 3. The daily returns on Aluminum from Monday through Friday are -0.000163 (p-value 0.0001), -0.000312 (p-value 0.47), 0.000369 (p-value 0.39), 0.000131 (p-value 0.002), and 0.000939 (p-value 0.029) respectively. Overall F-value of the regression is 5.885 with significance level of 0.0001 indicating that mean daily returns for different days of the week on Aluminum are statistically different from zero. However, the mean daily Aluminum return on Thursday and Friday are statically positive and Monday returns are statically negative, and the returns Tuesday and Wednesday are statistically indifferent from zero. Thus, the results in Table 3 indicate presence of the day-of-the-week effect in Aluminum returns.

Table 4 shows the results for the presence of seasonality in second moment. We can reject the null of homogeneity of variance across days of the week in both Copper and Aluminum. The results in Table 4 indicate that there may be a daily seasonality in the variance of these metals.

3.2 January Effect

Table 5 Moments of the Distribution by Month of the Year
August 27th 1987 through September 2012

		Mean	Std. Dev.	Kurtosis	Skewness	N
Copper	January	-0.008774	0.066319	-0.549	0.486	23
	February	0.009652	0.073237	-1.016	0.215	24
	March	0.037954	0.078586	0.354	1.002	24
	April	0.012642	0.079414	1.392	0.964	24
	May	0.023806	0.104541	3.226	1.344	24
	June	-0.019300	0.078199	-0.741	-0.218	24
	July	0.006093	0.078852	1.909	-0.471	24
	August	0.032032	0.074636	-0.018	0.348	24
	September	0.005496	0.049548	2.849	1.067	24
	October	-0.024464	0.080666	1.340	-0.842	24
	November	-0.013055	0.096294	5.284	-1.549	23
	December	0.017710	0.084738	-0.511	0.248	23
Aluminum	January	0.017066	0.064544	4.745	1.305	25
	February	0.014207	0.076977	-0.775	-0.349	25
	March	0.009330	0.077674	1.263	0.391	25
	April	0.000855	0.077847	4.094	1.538	25
	May	0.002332	0.071198	1.062	0.412	25
	June	0.000645	0.127040	16.660	3.712	25
	July	-0.006650	0.091001	5.652	-1.590	25
	August	0.022302	0.069299	0.347	1.043	25
	September	-0.012155	0.048024	-0.651	0.130	25
	October	-0.004875	0.076021	0.231	0.003	26
	November	0.001207	0.067689	0.349	0.051	25
	December	0.000176	0.078633	2.533	-1.235	25

The results of January Effect for Copper and Aluminum are reported in Tables 5-8. Basic statistics shown in Table 5 indicate negative monthly returns on Copper for January (-0.008774, skewness 0.486); June (-0.019300, skewness -0.218), October (-0.024464, skewness -0.842); and November (-0.013055, skewness -1.549). The average monthly Copper returns in March is the highest, while the remaining seven months of the year have positive returns.

Table 6 Levene's Test for Homogeneity of Variance for January Effect

	Levene Stat	Significance
Copper	0.927	0.336
Aluminum	0.796	0.373

Table 7 Monthly Return Data from December 1988 through September 2012

Monthly Effect Results for Mean Monthly Returns on Copper

$R_{it} = \beta_{iJ} D_{iJt} + \beta_{iF} D_{iFt} + \ldots\ldots + \beta_{iD} D_{iDt} + e_{it}$

Month of the Year	Unstandardized Coefficients		Standardized Coefficients	t	p-value*
	B	Std. Error	Beta		
January	-0.008775	0.016639	-0.030897	-0.527350	0.598379
February	0.009653	0.016289	0.034720	0.592603	0.553937
March	0.037955	0.016289	0.136517	2.330099	0.020530
April	0.012642	0.016289	0.045471	0.776103	0.438360
May	0.023806	0.016289	0.085624	1.461454	0.145041
June	-0.019300	0.016289	-0.069417	-1.184834	0.237114
July	0.006093	0.016289	0.021914	0.374032	0.708671
August	0.032032	0.016289	0.115211	1.966457	0.050259
September	0.005496	0.016289	0.019769	0.337415	0.736064
October	-0.024464	0.016289	-0.087991	-1.501845	0.134293
November	-0.013055	0.016639	-0.045968	-0.784593	0.433372
December	0.017710	0.016639	0.062359	1.064361	0.288106
F-value	1.527	Sig F**	0.114		N = 285

Note: * denotes probability that βij = 0; ** denotes probability that βiJ = βiF = …. = βiD.

Table 8 Monthly Return Data from September 1987 through September 2012

Monthly Effect Results for Mean Monthly Returns on Aluminum

$R_{it} = \beta_{iJ} D_{iJt} + \beta_{iF} D_{iFt} + \ldots\ldots + \beta_{iD} D_{iDt} + e_{it}$

Month of the Year	Unstandardized Coefficients		Standardized Coefficients	t	p-value*
	B	Std. Error	Beta		
January	0.017066	0.015844	0.062801	1.077166	0.282305
February	0.014208	0.015844	0.052282	0.896734	0.370607
March	0.009330	0.015844	0.034334	0.588895	0.556392
April	0.000855	0.015844	0.003145	0.053946	0.957015
May	0.002332	0.015844	0.008580	0.147168	0.883102
June	0.000645	0.015844	0.002375	0.040733	0.967537
July	-0.006650	0.015844	-0.024470	-0.419714	0.675006
August	0.022302	0.015844	0.082069	1.407643	0.160311
September	-0.012155	0.015844	-0.044730	-0.767204	0.443587
October	-0.004875	0.015536	-0.018293	-0.313764	0.753926
November	0.001207	0.015844	0.004441	0.076172	0.939335
December	0.000176	0.015844	0.000649	0.011132	0.991126
F-value	0.432	Sig F**	0.95		N = 301

Note: * denotes probability that βij = 0; ** denotes probability that $\beta_{iJ} = \beta_{iF} = \ldots. = \beta_{iD}$

Table 7 shows the regression results for January effect in Copper markets. The mean monthly return for March (0.037955) is significant at 5 percent while mean monthly return for August (0.032032) is significant at 10 percent. The overall F-value of 1.527 (p-value 0.114) shows absence of January effect. The monthly returns for March and August are statistically positive, while mean returns for other months of the year are statistically insignificant. The results do not support presence of the January Effect in Copper return during the analysis period.

The results of January effect on Aluminum in Table 8 show an insignificant F-value of the regression indicating mean monthly returns for different months of the year are not statistically different from each other. In addition, the mean monthly returns for all twelve months of the year are statistically insignificant. Therefore, the results of this paper show absence of the January Effect in Aluminum market for the period analyzed.

Table 6 shows the results for the presence of seasonality in second moment. We cannot reject the null of homogeneity of variance across months of the year in both Copper and Aluminum. The results in Table 6 indicate that there is no seasonality in monthly variance of these metals.

4. Conclusion

The analysis of the daily returns in Copper and Aluminum markets shows presence of day-of-the-week effect in both Copper and Aluminum markets. The mean daily returns in Copper are significantly positive for Friday which is consistent with the common day-of-the-week effect in equity markets. Monday's daily return in Copper is negative but statistically insignificant. The results of this paper show presence of the day-of-the-week effect in Aluminum market. The eman returns on Monday are statistically negative, while the returns on Thursday and Friday are statistically positive. The results of this study also indicate that there may be a daily seasonality in the variance of these metals.

The results of this study do not support presence of January effect in both Copper and Aluminum markets. The findings of this study indicate that there is no seasonality in monthly variance of Copper and Aluminum.

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